METHOD AND APPARATUS FOR DETECTING A TOUCH ON A DEVICE

FIELD OF THE INVENTION

[0001] The present invention generally relates to detecting a touch on a device, and more particularly to the use of at least one phase locked loop to detect a touch on a device.

BACKGROUND OF THE INVENTION

[0002] Oftentimes public-safety officers will need to use a device while they are wearing gloves. For example, fire fighters battling a fire will often wear gloves. This makes operating any touch-sensitive electronic device practically impossible. For example, the fire fighter's radio is often equipped with a touch screen. Using the touch screen by a fire fighter who is wearing gloves is practically impossible. Therefore, a need exists for a method and apparatus for detecting a touch on a device that alleviates the above-mentioned problems.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0003] The accompanying figures where like reference numerals refer to identical or functionally similar elements throughout the separate views, and which together with the detailed description below are incorporated in and form part of the specification, serve to further illustrate various embodiments and to explain various principles and advantages all in accordance with the present invention.

[0004] FIG. **1** is a block diagram of touch-sensitive circuitry.

[0005] FIG. **2** illustrates a touch-sensing device.

[0006] FIG. **3** is a flow chart showing operation of the device of FIG. **2**.

[0007] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions and/or relative positioning of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of various embodiments of the present invention. Also, common but well-understood elements that are useful or necessary in a commercially feasible embodiment are often not depicted in order to facilitate a less obstructed view of these various embodiments of the present invention. It will further be appreciated that certain actions and/or steps may be described or depicted in a particular order of occurrence while those skilled in the art will understand that such specificity with respect to sequence is not actually required.

DETAILED DESCRIPTION

[0008] In order to address the above, mentioned need, a method and circuitry for detecting a touch on a device is provided herein. The circuitry comprises two antennas coupled to two voltage-controlled oscillators (VCOs). A phase locked loop (PLL) is provided coupled to the VCOs. Switches are provided so that only one VCO output at a time will appear at a prescaler input of the phase locked loop. The PLL compares a VCO output with a frequency source (temperature compensated crystal oscillator (TCXO)), and outputs a tuning voltage (steering voltage) for the VCO that is based on the difference between the VCO frequency and the TCXO frequency. The steering voltages for each VCO are compared, and a decision is made as to whether or not a touch has been made to the antennas. If the antennas have been touched, a location of the touch is determined based on a difference in the steering voltages of the two VCOs.

[0009] In one embodiment of the present invention, the two VCOs are preferably operating at similar frequencies. Additionally, both VCOs are designed to be substantially identical so that both VCOs will have a similar amount of frequency drift (and thus a similar amount of steering voltage drift) over temperature and self-compensated when the difference of the steering voltage is used to determine a touch position.

[0010] Expanding on the above, when a user touches an antenna that is coupled to a VCO, the effective inductance of the antenna is changed and thus the resonance frequency of the VCO coupled to the antenna is changed. This causes the PLL to change the steering voltage of the VCO. Touching the antenna at different positions will give different effective inductance and thus produce different amount of frequency change, and thus a different steering voltage. A hand touch will give larger amount of frequency change compared to a glove touch and different gloves will give different levels of frequency change due to different amount of capacitance introduced at the antenna.

[0011] When two antennas are arranged to lie in parallel, and in opposite directions a change of the two VCOs frequencies can be used to not only determine that a touch has been made to the antennas, but also used to determine a relative position of the touch on each antenna. For example, for a particular antenna configuration, when the change of frequency at VCO**1** is larger than the change in frequency at VCO**2** it indicates that a touch is made at one end of the antennas and vice versa; while if both frequency changes are about the same, then it indicates that the touch has occurred at the center of both antennas. The two antennas may terminate as open or grounded, so that the open/grounded end of a first antenna lies adjacent to the VCO input of another antenna, and vice versa.

[0012] FIG. **1** is a block diagram of touch-sensitive circuitry. As shown, the circuitry in FIG. **1** comprises first VCO **101**, second VCO **102**, and PLL **103**. VCO **101** and VCO **102** comprise an electronic oscillator whose oscillation frequency is controlled by an input voltage (steering voltage). The VCOs may operate at the same, or differing frequencies. The applied steering voltage determines the instantaneous oscillation frequency of the VCO.

[0013] PLL **103** comprises a control system that generates an output signal (used as the steering voltage to each VCO) related to a phase difference between a source (TCXO **105**) and an output of a VCO (i.e., VCO **101** or **102**). TCXO **105** generates a periodic signal that is used as a comparison signal by PLL **103**. PLL **103** compares a phase of TXCO **105** with the phase of a VCO and adjusts the VCO until the phase difference is constant (signifying a matched frequency between the two), thus bringing the VCO frequency back toward the input signal generated by TXCO **105**. It should be noted that a divider (not shown) may exist to divide down the VCO frequency to lower freq to match with the TCXO frequency/phase.

[0014] The two VCOs are turned on and off by controlling switch SW**1** **108** and SW**2** **109** at the collectors of the VCOs (FIG. **1**). Only one VCO will be turned on at one time. The two VCOs will take turns to turn on in sequence. The VCO